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May 31, 2013

The Honorable Mark DeSaulnier, Chair
California State Senate Committee
on Transportation and Housing
State Capitol, Room 2209
Sacramento, CA 95814

The Honorable Ted Gaines, Vice Chair
California State Senate Committee
on Transportation and Housing
State Capitol, Room 2209
Sacramento, CA 95814

Dear Senator DeSaulnier and Senator Gaines:

Please accept this letter as a response to your letter of May 21, 2013, regarding my testimony at the May 14, 2013, Senate Transportation and Housing Committee hearing regarding the Bay Bridge.

I had coincidentally sent Senator DeSaulnier a letter on May 21, 2013, *Re: Summary of Decision to Follow National Standards for Bolts and Testing*, along with eight attachments that addressed many of your questions. In particular, that letter answered your first and second questions about why the decision was made to use high-strength galvanized bolts and provided documents explaining how the decision was reached. I have attached my prior response for purposes of maintaining continuity.

As I endeavor to answer your remaining three queries in this letter, I will also note instances in which that information was included in those prior materials.

The engineer of record on the Self-Anchored Suspension (SAS) span of the San Francisco-Oakland Bay Bridge is T.Y. Lin International/Moffatt & Nichol, a joint venture, which began design work in November 1997. The design is based on standards and criteria from guidance documents, as well as from project-specific Design Criteria which was provided to you on May 21, 2013. Electronic correspondence regarding the decision first to use this particular kind of steel fastener, and the subsequent decision of how to provide it with corrosion protection was detailed in the attachments to that May 21, 2013, letter.

You also ask about the review process of the design. The work of the design consultant team was followed very closely by the Caltrans Design Oversight Team. Regular check points were established throughout the progress of the work as required by the design contract. The final design package also was reviewed by various Caltrans technical committees; one in particular was the Caltrans Structural Steel Committee. Correspondence from that committee also was included in the information package provided on May 21, 2013.

Members of the Design Joint Venture's Engineering Team include:
Rafael Manzanarez, Design Manager (no longer on the project)
Marwan Nader, Project Engineer
George Baker, Design Engineer
Doug Williams, Consultant for Welding/Steel Fabrication
Karl Frank, Consultant for Fasteners
Jim Rucker, Specifications Engineer

Regarding the frequency and location of design meetings, there were hundreds of such meetings, most of which were regularly scheduled, and others held on an as-needed basis. Most of the meetings were held at either the Project's "Pier 7" complex in Oakland or the design consultant's offices in San Francisco. The materials sent on May 21, 2013 contain electronic communications, correspondence and other records from those meetings that pertain to bolt selection.

You asked about the corrosion expert mentioned during the hearing. That individual is Robert Reis. He expressed initial concerns about embrittlement, but later accepted the corrosion solution because extra testing requirements were imposed according to national industry standards set by the American Society for Testing and Materials. In particular, an email from Allan Chow on March 27, 2003, represents that, in relation to the steel connectors, Mr. Reis initially "had concerns with strain age embrittlement and suggested to test the final product with ASTM A143 'Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement'." However, a subsequent email from T.Y. Lin on April 2, 2003, discussed the Richmond-San Rafael Bridge and how this issue was addressed by using a "4 hour window between blast cleaning and hot-dip galvanizing", and included an addendum for the project delineating this process. Mr. Reis responded "This looks good" on April 3, 2003. These emails were included in the May 21, 2013, documents provided.

You also requested information regarding the 424 tower anchor rods located at the base of the tower. We are able to access the 424 tower anchor rods and already know the tension levels of each rod. These rods are enclosed in a dehumidified zone to reduce the possibility of corrosion. These anchor rods are designed to resist twice the force that the tower base would expect to see, which would come from the seismic ground motions used in the design. We do not expect any rods to fail given these parameters, but we have twice as many as we need.

Regarding your questions about the 274 bolts that anchor each strand of the main cable, they are accessible and tension levels can be tested, although the tension level of each rod is already known based on monitoring during installation and construction. The tension level of these bolts is far below the 0.7 FU tension of the bolts that broke. As Dr. Maroney discussed during his testimony on May 14, 2013, hydrogen embrittlement requires three elements: 1) high levels of tension 2) susceptible material (e.g., too hard, low toughness), and 3) the presence of hydrogen through manufacturing or environment or both. Again, the anchor rod bolts are at relatively low tension levels. More importantly, however, these anchor rods have been performing as expected for more than eight months and will also be enclosed in a dehumidified chamber, which further reduces any risk of hydrogen exposure. Additionally, the design of the main cable has a safety factor of two, meaning that it has been designed to resist twice the load that it will ever see. As is true with the tower rods, we would not expect any rods to fail given the cable has twice the capacity of expected forces which include the greatest earthquake motions designed for.

You asked whether bolts on the bridge are at risk of hydrogen embrittlement over time. The only good thing about hydrogen embrittlement is that it is easy to spot early on because it leads to bolt failure shortly after tensioning. To date, the only bolts that broke are the 32 bolts on the pier and all others on the bridge are performing as required—many after months or years of tension. In other words, if there was an issue with hydrogen embrittlement elsewhere on the bridge, we would have already seen failures. This conclusion has been supported by leading experts, including Dr. Fisher and Mr. Salem Brahimi.

Although the short-term risk of embrittlement has likely passed, we are conducting additional testing known as the Stress Corrosion (Townsend) Test to determine if all bolts will meet the long-term performance requirements for the bridge over the design life. Regardless of these test results, all elements of the bridge will be regularly inspected as part of the routine maintenance program throughout its life. We will not make any final decisions about short-term or long-term risk until all testing is concluded, the investigation is finished, the Peer Review Panel has been consulted and the Federal Highway Administration has concluded its independent review.

And regarding your final question, Dr. Fisher's involvement with the Bay Bridge project began in 2006, well after the design phase was completed. Dr. Fisher is thoroughly involved with the evaluation of the bolts for the design purpose today. Mr. Reis was involved in early decision making and his comments have been summarized above, and provided in the May 21, 2013, documents.

I take the construction and management issues on the Bay Bridge very seriously. First and foremost, the San Francisco-Oakland Bay Bridge East Span will be seismically safe when it opens. My team continues to work through current challenges with external peer reviewers to ensure that we are delivering this project safely.

Thank you for your leadership on this issue. I believe that elected officials getting appropriate answers to legitimate questions is a critical element in giving Californians the confidence they deserve in their transportation infrastructure, the very backbone of our state's economic potential.

Sincerely,

MALCOLM DOUGHERTY
Director

Enclosures:

Letter addressed to Senator DeSaulnier dated May 21, 2013
Summary Timeline of Decision to Follow National Standards for Bolts Set by American Society for Testing and Materials (ASTM)
SAS Design Criteria
Caltrans Bridge Design Specifications
ASTM Standard Specifications for Steel Bolts
ASTM Standard Specifications for Zinc Coating
ASTM Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
E2-T1 Special Provisions